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can endure drying for about a half year at least. The algae endure large amounts of moisture, perhaps better than the lichen hyphae, but the hyphae endure dryness better than the algae. It would add greatly to the value of the research if the cultures could be kept long enough to ascertain the time and conditions necessary for the development of podetia and apothecia.—
BRUCE FINK.

Light in relation to tree growth.—A recent bulletin from the Forestry Service, by ZON and GRAVES,¹⁴ will be welcomed by botanists and foresters as a valuable addition to their literature. The authors first show the influence of light on the life of the tree, then discuss the most noteworthy experiments in measuring this influence. The different kinds of light, namely, direct and diffused, and overhead, side, and reflected, are described. Diffused light is the most important, but some plants need direct as well as diffused light, either during their entire life, or at their time of flowering and leafing. An interesting table is given showing the decrease of both direct and diffuse light with increase of latitude, direct light decreasing most, till at the pole it is zero, whereas diffused light is 20. At the equator direct light is 489 as against 227 for diffused light. The rôle of direct and diffused light in trees and forest development, as well as variation of these light quantities with altitude and latitude, is discussed. The minimum light needed for various trees receives attention, considerable data on this topic being cited from WIESNER's well-known researches.

The greater part of the Bulletin is devoted to tolerance, the ability of plants to endure shade. The factors affecting tolerance and the methods of determining it are fully discussed. The results of LUBIMENKO and of GRAFE, dealing with the effect of sensitiveness of the chloroplast and of anatomical structure upon tolerance, are briefly stated. There is also a statement of the influence of climate, altitude, soil moisture, soil fertility, and age, vigor, and origin of the trees upon tolerance. Lists of trees are given showing the order of tolerance as determined by various European and American workers. Finally, the methods of determining tolerance are considered under three heads: (1) empirical methods; density of crown, self-pruning, number of branch orders, natural thinning of stand, conditions of reproduction, relative height, and artificial shading; (2) anatomical and physiological methods; structure of leaves and assimilation capacity of leaves; and (3) physical methods; measurement of luminous light intensity and measurement of chemical light intensity. The authors emphasize the general agreement in order of tolerance of various species as determined by the empirical and by other methods. They also point out the weak points in the various methods. One feels that ZEDERBAUER's luminous light method is underrated; while WIESNER's photochemical method, with its evident shortcomings, is over-

¹⁴ ZON, RAPHAEL, and GRAVES, HENRY S., *Light in relation to tree growth*. U.S. Dept. Agric., Forest Service, Bull. 92. pp. 59. 1911.

valued. Both of these methods are defective in that they fail to recognize the importance of non-luminous rays in plant processes, a fact that has been thoroughly established by BROWN and ESCOMBE.—BARRINGTON MOORE.

Plant formations of Caithness.—A report by CRAMPTON¹⁵ on the ecology of some of the northern parts of Scotland relates the development and succession of the various plant associations to the physiography of the region to an extent quite surpassing previous discussions of the vegetation of the British Isles. There is also a dynamic point of view maintained throughout and particularly emphasized in the study of the progressive and retrogressive phases of the moorland formation. The author not only recognizes the stable and successional formations of the topographic cycles, but also the regional successions as exemplified in the remains of tundra, forest, and moorland vegetation found in the peat mosses. This full appreciation of the dynamics of plant formations marks the study as one of first rank, and indicates a decided advance for British ecologists.

The extinct formations recognized are the pine forests, the tundra, and the arctic peat mosses, all related to the advancing and receding ice sheets of the geological period of glaciation, while the existing formations include the alpine and subalpine, the moorland, and, in less prominent development, those of the drainage system and coastal belt. From the exposure and altitude of most of the area studied, associations of sphagnum and other mosses and of the heather are the most abundant types of vegetation. Among the problems discussed, two may be cited as of special interest and as indicating to some extent the scope of the work. The one deals with the relationship of the *Calluna* mat of the alpine plateaux to the destructive winds, resulting in the development of a series of ridges and troughs of vegetation; the other is a part of the ecological relations of the moorland to the drainage system, and demonstrates the present decline of the peat bogs with the advance of river erosion. The reaction of sphagnum growth upon drainage and erosion is also carefully considered, as well as the competition between *Sphagnum* and *Calluna*, the two most conspicuous members of the moorland vegetation.—GEO. D. FULLER.

Fertilization in *Taraxacum*.—RAUNKIÄR's castration experiments on several forms of *Taraxacum*, as well as MURBECK and JUEL's cytological investigations, have proved that parthenogenetic or apogamous development of the embryo prevails in this genus. DAHLSTEDT later published the view that in two or three species of *Taraxacum* grown in a Belgium garden pollination seemed necessary to seed formation. ROSENBERG has described the normal occurrence of the reduction division in the nucleus of the embryo sac mother cell of *Taraxacum*, and HANDEL-MAZZETTI has announced the appearance of

¹⁵ CRAMPTON, C. B., The vegetation of Caithness considered in relation to the geology. pp. 132. Edinburgh: Published under the auspices of the Committee for the survey and study of British vegetation. 1911.